

COMPOSITION

AND THE

IBM

"SELECTRIC"[®]

COMPOSER

IBM

OFFICE PRODUCTS DIVISION
CUSTOMER ENGINEERING

OCTOBER 1966
FORM / PART NO. 241-5319-0

COMPOSITION AND THE IBM "SELECTRIC" COMPOSER

PURPOSE

To provide a general knowledge of the Printing Industry and the position of the IBM "Selectric" Composer within this industry.

The quality of the print obtained from the IBM "Selectric" Composer is influenced by such factors as units of escapement, style of type, ribbons, papers, and the overall adjustment of the IBM "Selectric" Composer.

The quality of a finished publication, whose copy was prepared on an IBM "Selectric" Composer, is directly dependent on the quality of the original copy. However, the intermediate steps between the copy preparation and the final processing have a pronounced effect on the final results. A Customer Engineer should have a basic understanding of these intermediate steps. To aid in this understanding the following topics will be discussed in this publication:

1. Composition Machines
2. Unit System
3. Type Design
4. Supply Items
5. Photo-Lithography
6. Offset-Lithography

The production process of a publication is a complex enterprise. The preparation of camera-ready copy, the application of the IBM "Selectric" Composer* in this field, is only one of many steps. Here is a thumb-nail description of each of the basic ingredients:

1. ROUGH COPY ---

This is the written part of the job; the text, descriptions, headlines, tabular matter, etc. Usually it is prepared before layout is made, although in some cases copy is written to fit a pre-conceived layout.

2. LAYOUT ---

This is the "blueprint" - an artist's conception of the finished job. Layouts are usually prepared on transparent paper with pastels or pencil, then mounted on opaque sheets.

3. FINISHED ART ---

This includes illustrations, hand lettering, charts, color blocks, etc., ready to be made into plates. It follows the layout as a guide.

4. PHOTOGRAPHS ---

Similar to finished art, photographs can be corrected if necessary by retouching, before plates are made. Glossy prints of black and white negatives are usually used.

5. COMPOSITION --- (Finished Copy)

This is copy set in type - either machine set or hand set. Proofs are usually submitted in "galley" form to be read for corrections.

6. LITHOGRAPHIC PLATES ---

In offset lithography, everything - type matter, photographs, art, etc. - is transferred to a thin flexible metal plate through a mechanical process of photo-chemistry.

7. PAPER ---

Unlike some of the other ingredients, papers come in an astonishing variety of brands, types, weights, textures, colors, and prices. There is always the right paper for the specific job.

8. PRESSWORK ---

After plates are approved, the job finally is ready to be run. The size and type of press, inks, and method of running will have been determined.

9. PROCESSING ---

Finished press sheets go to the bindery or processor for any of a number of operations, depending on the job. These include laminating, die-cutting, embossing, cutting, folding, punching, stitching, collating, trimming, etc.

The composition preparation, as you can see, is only one part of many necessary steps between an idea and a finished publication. It is only at the composition stage that the "Selectric" Composer is brought into use. To better understand the advantages of the IBM machine and how it compares with other compositors, a quick look into the history of printing is desirable.

COMPOSITION MACHINES

The development of movable type during the fifteenth century was the beginning of a new method of communications. The ability to reach a large audience simultaneously was seemingly within reach. However, the time required to hand set the type and operate a screw-type hand printing press still limited the production of printed material.

Invention of the "Linotype" and "Monotype" type casting machines, in the nineteenth century, provided the means for accelerating the job of type composition. Other related developments were being made in the field of graphic arts, and the dream of rapid mass communication with printed copy began to be realized. High speed presses, linecasting compositors, and photographic processes all combined to speed the exchange of printed material and to help usher in the twentieth century.

The Printing Industry in the past 20 years has seen a remarkable increase in the number of systems for set-

ting copy. While differing widely in techniques, cost, and in products, all of these systems have tended to be arbitrarily classified by the industry under various catch-all names. The phrase "Cold Type" has come to encompass all composing systems which are not "hot metal". That is, any system which avoids the use of molten metal cast into slugs such as "Linotypes", "Intertypes", "Monotypes", and "Ludlows", can be considered Cold Type. For our purposes, we will further define Cold Type into two categories - Photo Composition and Direct Impression.

The "Hot Type" compositor, as the name suggests, uses molten metal to mold the actual type face. The metal is a mixture of antimony and lead. Machines such as "Linotype" and "Intertype" are typical hot type composition units found in newspapers, job printers, and other printing establishments where speed, print quality and line justification are all necessary ingredients.

Composition can be divided into two categories directly dependent on its composing requirements. These

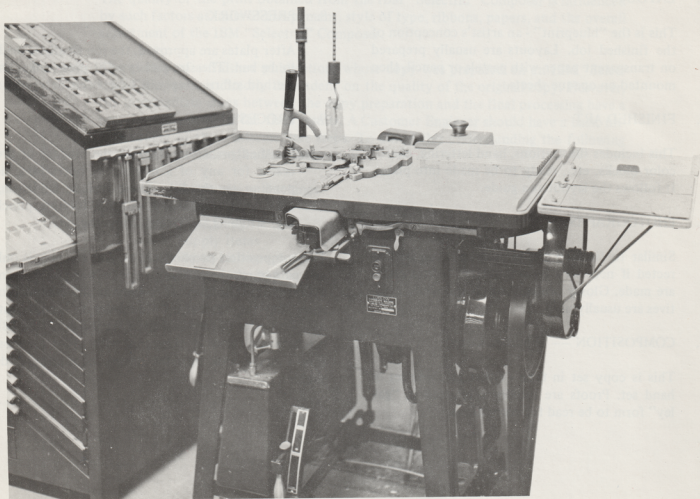


FIGURE 1. The Ludlow Typograph requires handsetting and is used primarily for headlines or display type.

categories are headlines and text and refer to the size of type desired rather than to context. Whenever the size type is too large to be composed on an automatic composer, such as is used in headlines or titles, there are two alternatives that may be considered. First, the material can be set by hand. This is accomplished by using type that has been previously cast. This type is usually stored in a special cabinet called a job case where each letter is distributed into its individual compartment. The assortment of type in the case is called a font, and it includes all the characters of one size of one kind and one style of type. Each letter must be hand placed by the composer in a holder called a composing stick. Each word is separated from the one that follows by a piece of spacing material, and which is

less than type high so that it will not print. When the printing job is completed the type is returned to the job case and redistributed for future use.

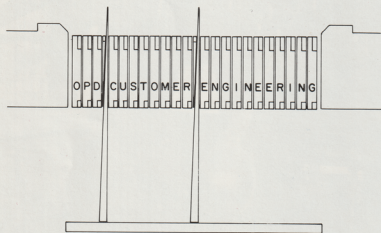
The second method of composing headlines is through use of the Ludlow Typograph as shown in Figure 1. This machine casts type in complete lines or slugs from matrices that are set and distributed by hand. Special Ludlow sticks or matrix holders are used for assembling the matrices and inserting them in the casting machine. The slugs cast on this machine may be used in type forms with slugs from a linotype machine without special treatment. Simple in operation, with a useful variety of type sizes, styles and accessories, Ludlow is a highly versatile, semi-mechanical method of typesetting.



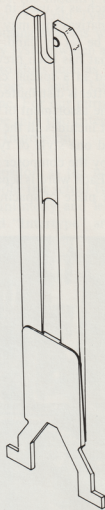
FIGURE 2. Linotype Machine



Matrix



Justification Operation



Spaceband

FIGURE 3. Linotype Machine Theory

A hot type line casting machine, as shown in Figure 2, in reality composes with matrices, not type. These small brass units have characters indented in their edges, hence the name "matrix" (Fig. 3). The matrices are assembled by the machine, through a keyboard not unlike a typewriter keyboard, into word groupings. A line of these word groupings are then separated by spacebands. A spaceband consists of two wedges of tempered steel interlocked so that the wedges may slide freely against one another while the outer edges remain parallel. Since this arrangement allows the spacebands to be adjustable in width, justification of a given line may be accomplished merely by expanding the spacebands to bring the line to its predetermined measure. A feature of this method is that it produces a justified line with equal spaces between words.

After being assembled, the line of spacebands and matrices are carried to a position in front of the casting mechanism. There they are justified or spread out to a predetermined length between a set of vise-jaws. The matrices are then aligned facing a mold. Behind the mold is the metal pot containing molten lead heated by electricity or gas. This metal pot locks against the back of the mold and a plunger forces molten metal forward into the mold cavity and the matrices. After cooling, a solid slug is formed. It should be noted that after printing this slug is melted down and the metal is used again.

The finished slug, as shown in Figure 5, along with others, may become a part of a plate for a letterpress operation and print directly onto paper; or a proof copy may be made ("pulled") and used as the camera-

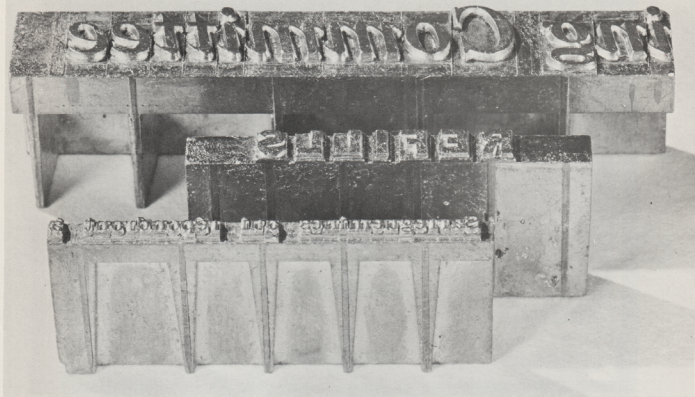


FIGURE 5. *Cast Lines of Type*

ready copy for the offset lithographic process. In either case it is first inked and then the paper is brought into contact with the type face. It may readily be seen from this operation that all of the type faces must be in the same plane. The process of leveling off the type form or plate by shimming with successive layers of thin tissue is called "make ready". Many hours may be spent in this tedious operation.

The normal progression of a letterpress operation, once the slugs have been cast, is primarily a preparation for the press run as shown in Figure 6. All the type is placed in galleys for page groupings. The type is tied up in string, inked and a proofing copy made to detect errors.

Once the galleys have been approved, they are assembled and locked in a large frame called a chase. As many as sixteen pages may be printed on a single sheet which is later folded and trimmed to the proper size. Large wooden blocks referred to as furniture are used as spacing material to hold the galleys firmly in position.

Now the chase is ready to be used as a base for printing. The locked form is placed in the press and a trial run is made to check the level of the printing surface. It is at this stage that the quality of the make-ready

spells the difference in the quality of the final product. The highs and lows are detected by the image variations and these are leveled out until the entire form presents a smooth surface to the pressure roller and paper.

After the make-ready is complete, the press run is almost entirely automatic. The paper is fed through the press, down the paper delivery, through a flame to heat set the ink, and is finally dropped onto a stacker unit where it is dusted with powder to suspend the following sheet until the ink has finished drying.

There are disadvantages to these machines. When letters need to be changed or respaced an entire line has to be reset. The height of the letters or lines may have to be shimmed to bring them all into the same printing plane. This make-ready is time consuming and requires an experienced craftsman. And finally, the high cost of equipment and the need for highly skilled operators severely restricts the number of users.

These hot type units are generally considered to be the acme of composing machines with respect to print quality. While it is true that there is a direct relationship between the print quality obtainable and the condition of the matrices, the character alignment,

FIGURE 6. Make-Ready Sequence

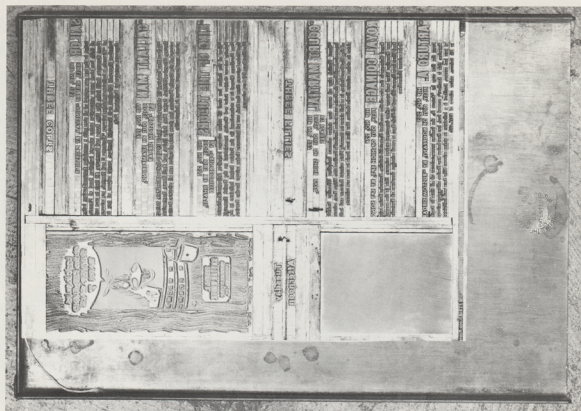


FIGURE 6A. Galley Tied Up With String For Proofing



FIGURE 6B. Chase Locked Up and Ready for the Press

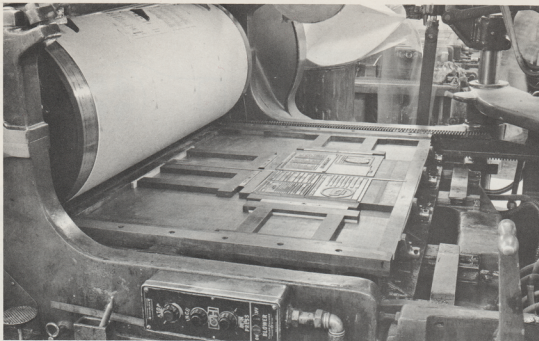


FIGURE 6C. Chase On The Letter Press

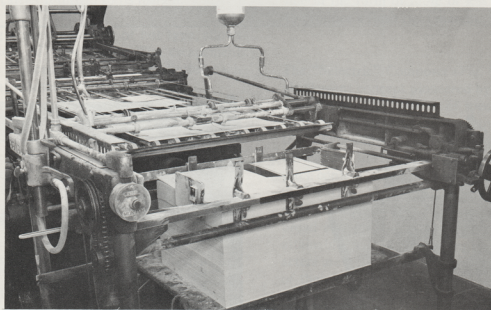


FIGURE 6D. Sheet Fed Stock Coming Off The Press

character coverage, edge definition and color possible with these units is outstanding. Coupled with this is the aesthetics of type design possible when character spacing and character width is dictated by letter balance and letter shape rather than by an escapement system.

The second category, Photo Composition, is a relatively new process. These machines produce composition that is of the highest quality in edge definition, character coverage, color and character alignment. The methods used to produce camera-ready copy makes possible a library of typesyles that is virtually unlimited, yet requires very little storage space.

Photo composers are slower than hot type machines as a result of the necessary developing process. However, the print quality and the alignment will be as good as, if not better than, that of hot type. Since these machines produce copy for camera, the reproduction process is limited to a lithographic offset press. The hallmark of a photo composer is the high graphic quality obtainable regardless of the typesyle or type size.

A standard electric typewriter keyboard is used in conjunction with a computer, to transmit coded signals identifying the characters and their width to a tape unit as shown in Figure 7. The typewriter may simul-



FIGURE 7. Recording and Projection Units of a Photo Composer

taneously produce a hard copy for detection and correction of errors. At the end of each line the necessary justification data is computed by the recorder and the carriage return is actuated.

After the job is typed, the tape is fed into a photographic unit as shown in Figure 7. The type font and

leading (line spacing) is selected and the unit composes the job as it decodes the tape, expanding the spacebars as needed to justify each line. The mechanics employed to produce the justified camera-ready copy from the original tape consists of a light source, the type font, a lens, and light sensitive paper or film (Fig. 8).

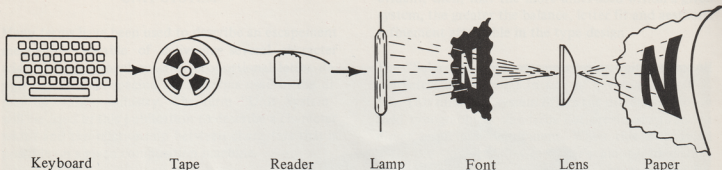


FIGURE 8. Photo Composer Logic Sequence

The type font is positioned for the character selected. The image from the font is then projected through the lens onto the light sensitive film. The film is mounted on a carrier system which has a leadscrew escapement system. It escapes the proper increment for the character selected, as coded on the tape. At the end of each line the film roll is indexed the selected amount and the carrier returned to its margin.

This composing process, like that of hot type, allows complete freedom of type design. The escapement system permits the proper space to be allotted each character so that balance of design is retained.

The disadvantages are primarily those of initial cost and service. These machines are relatively new on the market and few in number.

Direct Impression, the third category, describes the production of a cold type image by striking a character, through a carbon ribbon, against either paper or an offset master. Images are usually black on white and always positive reading. There are two machines offered by IBM for the field of cold type composition. They are the IBM "Executive" Typewriter and the IBM "Selectric" Composer.

The IBM "Executive" Typewriter has two features that raise it above the standard typewriter for composition. These are proportional spacing and the capability to produce line justification.

It is the least sophisticated of all direct impression machines being used for justified composition copy. To fill the needs of the printing industry with this unit, it would be necessary to possess a large number to satisfy the demands for typestyle variety alone. Additionally, the typeface design is somewhat restricted as a result of the escapement system. This escapement system of five units with only four character widths affects the natural balance between characters. The machine is versatile in application, how-

ever, in that it will do, with some restrictions because of typeface design, all the applications of the standard typewriter. Justification of a line is achieved on this machine by typing the copy twice. On the first typing, the necessary data to make a flush right margin is calculated by the operator line by line. On the second typing the data is introduced into each line in the form of more or less units between words to produce a flush right margin.

The "Selectric" Composer (Fig. 9) is built on the single element concept pioneered by the IBM "Selectric" Typewriter. The features of speed, character storage, and changeable type fonts common to the "Selectric" Typewriter have been retained. To these have been added the flexibility of selective leading, variable pitch control, character backspace and semi-automatic justification. The escapement mechanism allows seven character widths on a nine unit base, or a system broad enough to give character balance never before attainable with a direct impression machine. Characters are now assigned a width that is representative of their true shape. This makes it possible to preserve the fine aesthetic value of the type style and to satisfy the most stringent requirements of the printing industry. The "Selectric" Composer has incorporated the best features of all the direct impression machines. It has speed, flexibility, and the beauty of balanced type design.

The heavy dependence on supply items to produce acceptable copy, and the required double typing of copy to produce justified text is inherent in all operator oriented direct impression machines. The operator requirements for direct impression machines are not as stringent as other composing machines. A typist can produce acceptable justified copy or direct image plates after a minimum of instruction time. This allows for greater flexibility in selection of personnel and more latitude in operator training programs.



FIGURE 9. IBM "Selectric" Composer

Direct impression machines will be found in letter shops and in-plant printing shops where cost of equipment is an important item. Both initial cost and operating costs are less than any other composing system. The "Selectric" Composer, however, is the most versatile of the direct impression machines. Its outstanding features plus a more extensive escapement system than any other direct impression machine enables the "Selectric" Composer to produce the highest quality copy.

Some consideration must be given to the matching of supplies and the machine to obtain satisfactory results. When composing with direct impression equipment, the quality of the copy is directly dependent on the supply items used. The ribbon may cause line growth or loss of edge definition. The papers used can cause character voids or line breaks as a result of surface finish. Only experience will show which supply items may produce acceptable camera-ready copy or direct image plates.

UNIT SYSTEM

Many terms have been used to describe an escapement mechanism capable of delivering several character widths. Proportional spacing, proportional letter design and variable spacing are all terms used in the direct impression industry. The term "Unit System" will be used in this publication to describe a character width and the relationship between characters that is possible on a given composition machine.

Good type design within a given type style is based on full character proportion, both width and height. There is a direct relationship between the height and width of a character. In direct impression machines, the escapement mechanisms are able to deliver only a limited number of character widths. This limits the design of the type faces.

The IBM "Executive" Typewriter uses a five unit system. That is, all characters are allotted to one of four widths with the widest being five units (Fig. 10).

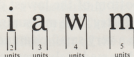


FIGURE 10. IBM Executive Unit System

The actual width of each unit, on a direct impression machine, depends on the pitch size. The IBM "Executive" Typewriter has three pitches of 1/42, 1/36, and 1/45 units per inch. A four unit escapement in 1/32 pitch produces a space 1/8 of an inch. A three unit escapement in 1/36 pitch produces a space 1/12 of an inch. Both the number of units and the pitch must be known to determine the space produced.

Hot Type and Photo Composition machines are not inhibited by an escapement system. These machines distribute character widths within an eighteen unit system. This system allows enough latitude to give the necessary balance and letter fit for a high quality of type design. Generally twelve units are used for alphanumeric characters as shown in Figure 11. It is



FIGURE 11. Hot Type Unit System

evident, then, that the more units used within a given system, the greater the balance, letter fit and aesthetic refinement attainable in the type design.

The "Selectric" Composer uses a nine unit system. All characters are allotted to one of seven widths (Fig. 12). This nine unit system offers the direct impression field typographical standards not previously found in direct impression equipment. When this is coupled with the "Selectric" Composer's ability to change pitch and type styles, the result is a machine that begins to rival the aesthetics of Hot Type and Photo Composition machines.

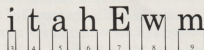


FIGURE 12. "Selectric" Composer Unit System

If the letter fit of these different composition machines is compared, in a similar type style and pitch, as in Figure 13, the relationship between the Unit System and the number of letters within a line of type becomes apparent. The number of letters, or density of letters, within a line is sometimes referred to as copy that is set "loose" or "tight" depending on the letter fit of the type. Again, the more units used within a given system, the tighter the letter fit, and the denser the copy line. With tight copy (dense copy line), a publication can use the same type style and require fewer pages than with loose copy. This becomes important when every additional page of copy means increased costs.

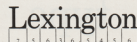
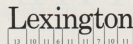


FIGURE 13. Letter Fit Comparison

When comparing units and type faces, it is necessary to have a constant frame of reference. The composition industry uses the established terms of the printing industry, since type design and composition originated from the printers' demands.

The basic unit of measurement for this industry is the POINT. A point is exactly .013837 inches or almost 1/72 of an inch. The term "point" is applied to the measurement of type and refers to the body size or metal shank on which the type is cast as in Figure 14. When the height of the body is eight points, the type is known as eight point type. If the body height is twelve points, the type is twelve point type. Metal types are made in a range of sizes from four point to seventy-two point. Point sizes ranging from six to twelve may be classified as body type (for text) and point sizes twelve and above fall in the classification of display type.

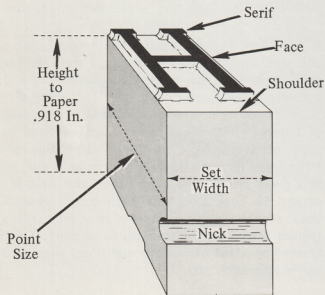


FIGURE 14. Single Piece of Type

Since the term "point" refers to the height of a type slug, the size slug used imposes a maximum measurement on the ascending and descending characters. In other words, the character, or type face, cannot exceed the type slug measurement. Generally, the maximum measurement of a given type style, or font, will be just slightly less than its point size. This is to insure that the lowest descender will not touch the highest ascender if the one slug were set on top of the other.

The height of a type slug has no direct bearing on the size of individual characters. This means that while various type styles may be of the same point size, an individual character may vary somewhat in depth within this measurement. The shape and height of individual letters is left to the artist's sense of balance and proportion. An example of the variation of letter size in three type designs of the same body or point size is shown in Figure 15. Normally, the size of the mid-portion of a letter varies from 1/3 to 2/3 of the body size.

When using the term "point" in reference to type size on the "Selectric" Composer, the measurement being referred to is the distance from the top of the highest ascender to the bottom of the lowest descender just as in the printing industry. The measurement still insures that there will be a very small clearance if a descender were to be placed immediately over an ascender.

Printer's type is cast of metal and has a body and a face. As previously discussed, type is identified to size by its body. Type is identified by its face as a particular type style. Common type styles are: Times Roman, Bodoni, Universe, Garamond, Gaston, and many others. Therefore, in requesting a particular type face, you must state both body size and type style, such as 12 point Times Roman.

TYPE

Century
Schoolbook

type

TYPE

Futura
Demibold

type

TYPE

Venus
Bold

type

FIGURE 15. Type of Same Point Size



FIGURE 16. Pica/Inch Scale

A printer measures line width and the length of his copy in PICAS. A pica (.166044 inches) is exactly twelve points or approximately 1/6 of an inch. The scales above, as shown in Figure 16, contrast the relationship between inches and the printer's pica. A 24 pica line would measure slightly less than four inches. The difference becomes increasingly noticeable as the length of line increases.

A term that is occasionally used, and sometimes substituted for pica is an Em or Em pica. The letter m is cast on a square shank. Therefore, a 12 point letter m is also 12 points wide or exactly one pica. However, a 10 point m is only 10 points wide and is not equal to a pica. The width of copy when measured in Em's merely establishes a relationship between line length and the point size of type. The resulting confusion has led to the abandonment of the term in most print shops for the standard measurement of picas for column width.

Printers speak of leading (pronounced ledding) to denote extra space between successive lines of type. When a printer speaks of copy that has no extra space between lines, he refers to copy as set "solid". The body of the type, as shown in Figure 17, contains suf-

ficient space to prevent overlapping of the ascenders and descenders. Therefore, six lines of 12TR/12 (12 point Times Roman set solid) equals 72 points (6 picas) in depth.

There is no problem in transferring these terms to the "Selectric" Composer. The typeheads are clearly marked as to point size and suggested leading as shown in Figure 18. When a type style becomes smaller in point size the width of the character must also become smaller. Here we see the machine gaining some of its flexibility of point sizes through the ability to change pitches. A given character always takes the same number of units of escapement but the actual width depends upon the pitch selection.

The scales on the "Selectric" Composer are graduated on the inch scale. The left margin sets in 1/6 inch increments, while the right margin sets in 1/12 inch increments. Although this is at variance with hot type measuring, it is consistent with other direct impression machines.

The selector dial on the platen controls the leading. The proper spacing can be chosen that will not only enhance the appearance of the copy, but also improve its legibility. Proper leading between long lines or lines set in bold type face helps to keep the eye from becoming confused by words and lines which seem to run together. Nicely balanced spacing of words and characters helps the reader grasp the meaning of the text without encountering stumbling blocks.

The layout or copy fitting may also dictate the leading selection. The copy will then be leaded to fit the width and length of a specified area within some larger piece of copy or graphic art.

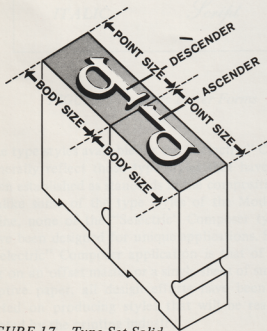


FIGURE 17. Type Set Solid

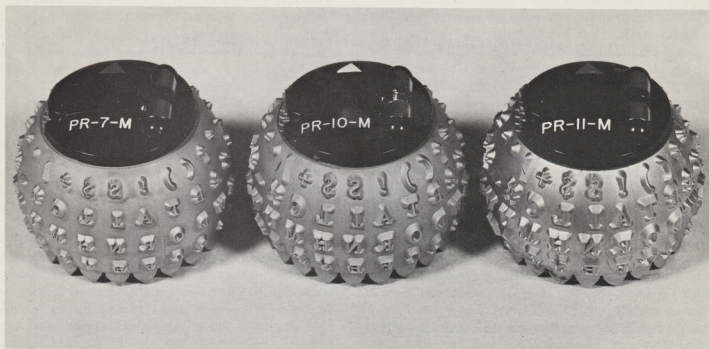


FIGURE 18. Type Fonts of Three Point Sizes

TYPE STYLES

The type faces commonly used in the printing industry are patterned after letter forms which were written in pen in early manuscripts. The four basic letter forms, as shown in Figure 19, are Text, Roman, Italic, and Script. The ones that have survived and are commonly used in the text of composition are Roman, for clarity, and Italic, for emphasis. A natural consequence of the popularity of the Roman form of letter is that many different type styles have been made available by the manufacturers of type. These type styles vary in degree as different people vary; and yet many of the variations are too subtle to be distinguished by untrained eyes. The artist's handling of curves, loops, stroke thickness, horizontal and vertical proportions and character to character balance determines the final appearance of a type style. When considered as a complete type font, the type style is as individualized as a person's signature.



FIGURE 19. Basic Letter Forms

The type styles available for the "Selectric" Composer generally reflect those type styles that have already been established as standards in the composition field. Unlike some of the type styles of the Model C machine, none of the "Selectric" Composer type faces have been designed for unique applications. Since the "Selectric" Composer application is that of imprinting on an offset master or a single sheet of smooth receptive paper, all design efforts have been concentrated on producing styles that will be readily accepted by the printing industry.

The type styles developed for the "Selectric" Composer, with their distinctive features, fall into five different classifications of type that are generally used in text writing. These type categories and their distinguishing characteristics are shown in Figure 20.

h	OLD STYLE
h	MODERN
h	TRANSITIONAL
h	SQUARE SERIF
h	SANS SERIF

FIGURE 20. Type Style Characteristics

The IBM names that have been chosen for these type styles are representative of their individual characteristics and meaningful to the printing industry. In addition to these classical type styles, symbol elements will also be offered for use in technical composition.

Each of the type styles will be available in different line weights. The line weight, or stroke thickness, will vary from light, through medium, to bold. In addition, an Italics version of each type style will be available for purposes of emphasis within a given text or captions.

The element cap will be color coded to show the correct pitch selection for that particular size of type. The cap will also contain information as to type style and point size as shown in Figure 18.

The size of type available for the "Selectric" Composer will range from six point to twelve point. Each point size of a type style corresponds to one of the three escapement pitches of the "Selectric" Composer. A large size type style will fit the largest escapement mode of the machine. As a type style diminishes in height it will also require less space per unit

TYPE SAMPLE

This reproduction is a sample of the distinctive type styles that have been matched to the sophisticated escapement system of the IBM "Selectric" Composer. These five type styles represent a cross section of the text faces used throughout the printing industry.

ALDINE ROMAN is an example of the old style type of Roman letter. The serifs of the characters are blunt and rounded, and there is little difference between the thick and thin stroke of the character. The delicate beauty of this face has attracted type designers throughout every century. ALDINE ROMAN is available in point sizes of 12, 10, and 8, both in medium weight and italics.

PRESS ROMAN is an example of the transitional designs that have successfully blended the old style with the modern. The thin strokes of the character presents a contrast while the serifs are rounded into the stem. It is the most widely used text face for newspapers, periodicals, journals and books. PRESS ROMAN is available in point sizes of 11, 10, 8, and 7, and in weights of bold, medium and italics.

BODONI BOOK is as modern as today. The character serifs are sharp and straight. The great contrast in the weight of the thick and thin strokes should make it one of the most popular faces with the printing industry. BODONI BOOK is available in point sizes of 12, 10, and 8. It is available in medium weight and italics.

PYRAMID is a newly designed example of the "Egyptian" or square serif type face. This type face has an evenness of weight with little difference between the thick and thin strokes. PYRAMID is used for subheads in normal text and is very popular for catalog printing. A famous example of the square serif is our IBM trademark. PYRAMID is available in point sizes of 12, 10, and 8, both in medium weight and italics.

UNIVERS has been especially adapted to the IBM "Selectric" Composer by its designer, Adrian Frutiger. It is only in recent years that this sans serif type face has blossomed forth in popularity. UNIVERS is widely used in the graphic arts and finds particular acceptance in technical literature such as specifications and product information sheets. UNIVERS is available in point sizes of 11, 10, 8, and 7. It is available in weights of light, medium, bold and italics.

FIGURE 20A. Type Faces Available With The IBM "Selectric" Composer

width and be relegated to one of the smaller escape-ment modes of the machine. It may readily be seen that the physical size of the typehead was the limiting factor on the point size of a type style.

One of the primary reasons for character arrangement on the element is the need for character clearance. It was found that when a type face prints on a single sheet of paper a side clearance of .008" is sufficient for most characters. For some of the large face-area characters even less clearance is tolerable, while more clearance is needed for character faces that will penetrate such as the period, comma, and colon. To reduce the exposure of over and under printing, the problem ascending characters, such as parentheses, were placed in the zero tilt band, and problem descending characters were placed in the tilt three band. The remaining eight and nine unit alphabetic characters were placed in the tilt two band where there is the maximum space available on the typehead circumference.

Another reason for the character arrangement is the effect on alignment. It was based on the tendency of the machine to misalign two characters that are in extreme rotate positions. The factors considered when choosing which characters to place in these positions were the frequency of printing and the sensitivity to vertical alignment. While this does not eliminate the misalignment, it does allow it to occur between characters where it is not readily detected or between characters that are infrequently used.

The major difficulty in type designing is that several manufacturing steps and an actual machine operation are necessary before a comparison can be made between the printed image and the original designed face.

First the typehead must be molded. The molding variations, such as character slide placement and uneven shrinkage over the element, will sometimes cause inconsistencies in character-to-character alignment. While these variations are extremely slight, it explains why a simple substitution of typeheads is occasionally effective in eliminating an alignment problem between two particular characters.

The plating process itself can produce line growth of about .001 of an inch. In addition to line growth, the plating tends to build up in the corners of characters and to round off sharp edges further modifying the designer's art as illustrated in Figure 21. While this line growth is an undesirable characteristic, it is compensated for in the initial design and contained through a strict control on the plating process during type font manufacture.

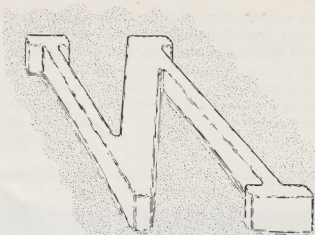


FIGURE 21. *Plating Effect On The Type Face*

In contrast to the "bright" type element used on the "Selectric" Typewriter, the "Selectric" Composer uses a type element having a dull, slightly rough finish. This finish has two advantageous qualities. The dull quality eliminates any possible adhesion between the ribbon film and typehead. This adhesion would lead to ribbon rewind problems. The slightly rough surface quality was needed to make the bold face types feasible on a "Selectric" Composer. Even with optimum adjustments and supply items there would be voids in the centers of wide character sections when using a smooth surfaced element for printing. The rough texture gives better ribbon ink transfer as a result of the increased coefficient of friction between the ribbon and type face.

The final step before the printed character may be compared with the original artist design is an actual machine printing operation. A variable that is inherent in this operation is the character penetration. Character penetration will vary because of character shape. This variation in penetration results in character-to-character variation in line spread, since line spread is a result of penetration. This varying line spread, as a result of the varying penetration by characters, could destroy the type design balance unless it were eliminated, or at least equalized. This problem led to the development of three print impact levels. Each character was assigned to a specific level on the basis of ability to penetrate. Since the medium and high level velocity can be selected in either upper or lower case for any alphabetic character, the desired flexibility was gained and the line spread equalized.

Now the printed character reflects not only the artist's design, manufacturing processes, but also the modifying supply items that are used with the machine.

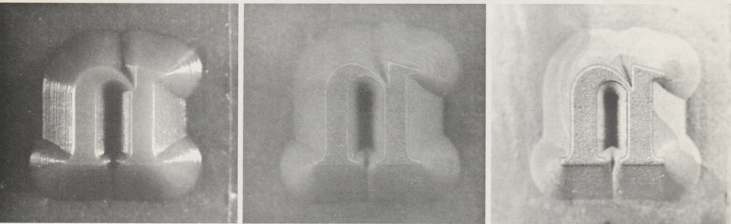


FIGURE 21A. Type Face, Unplated, Blasted, and Plated

RIBBON

The ribbon on a direct impression machine is the medium by which the character image is transferred from the type face to the paper. To make this transfer the type face must have sufficient impact to cause the ribbon ink to break loose from the film and adhere to the paper. Therefore, a reproduction of the type designer's art, already slightly modified by the type element manufacturing process, will be further modified as it passes through the ribbon film and ink onto the paper. To minimize this modification of the type design, a ribbon ink must be formulated with the characteristics of cleanliness, total character coverage, color balance, crisp edge definition, and yet not incur line spread due to the ribbon film thickness.

Whenever a type face strikes the ribbon and paper it causes the ink layer to fracture at the character edges. As the ink layer fractures it also transfers from the film to the paper. It is this necessary fracturing of the ink that largely produces the extraneous ink particles that are referred to as flaking.

These flakes or loose particles are most often present around the edge of a character, and as a result contribute to poor edge definition. In addition, the presence of a flake means that there is a spot on the ribbon that same size which has no ink. If the type face strikes the ribbon where a flake has been generated the resulting image will have a void the same size as the flake.

Since the generation of these extraneous ink particles is inherent in any impact printing, it is the chemical make-up of the ink that determines the degree of cleanliness of the printing operation. These characteristics are controlled by the ribbon ink brittleness and ribbon release qualities.

Total character coverage, even with bold type styles, is dependent on the release characteristics of the ribbon. It was found that the wax based 3121 ribbon did not give acceptable coverage even with the dull nickel type element. A new ribbon was developed with an entirely new chemistry to meet the need. When a graph (Fig. 22) is plotted on its release qualities with refer-

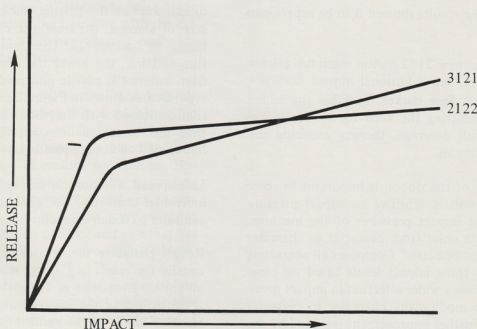


FIGURE 22. Release vs. Impact Graph of Two Ribbons

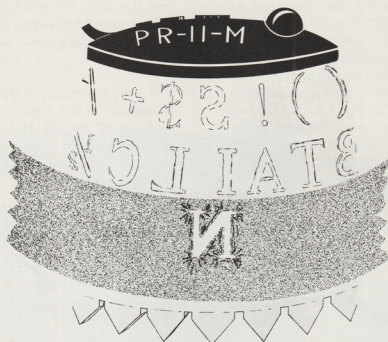


FIGURE 23. *Film Ribbon Molds To The Type Face*

ence to impact the results showed it to be superior to the 3121 ribbon.

Not only does the new 2122 ribbon reach full release at a lower impact, but additional impact does not make the character face darker. This has the added advantage of eliminating the need for increasing impact to obtain full coverage, thereby reducing embossing to a minimum.

The release curve of the ribbon is important in color balance. If a ribbon is sensitive to impact pressure over the different impact pressures of the machine, then a variation in color from character to character will result. In the "Selectric" Composer all characters are grouped into three impact levels based on character size. This gives a wider selection in impact pressure and tends to modify any character to character color variation. Further improvement is gained by the better release qualities of the ribbon.

The effect of ribbon line spread on character aesthetics is the same as that described for plating. When both are present they are additive, and magnify the slurring of the type face. This slurring, or distortion of the type face, is an undesirable but unavoidable con-

dition. Just as the plating thickness dictates the degree of slurring, the ribbon thickness is a controlling factor in line spread. The thinner the ribbon, both film and ink, the lower the line spread. The ribbon film material is plastic and readily conforms to the type face as shown in Figure 23. This plasticity of the film combined with the ribbon chemistry, which controls the release qualities, are the means of limiting line spread on impact printing.

Line spread is important not only because it slurs the individual character, but also because it enlarges the exposure to rough character line edges.

Rough character line edges, or edge definition, are usually the result of flaking, machine smear, texture, or any combination of these three qualities. Flaking is controlled by the ink formula as previously stated. Machine smear is the result of the type face moving relative to the paper while in contact, and can be eliminated by either machine adjustment or replacement of parts. Texture is actually the superposition of three textures: type face, ribbon granules, and paper surface. Of these three textures, only the paper can be successfully varied for better quality printing. This is more fully covered under the paper chapter.

Color intensity or blackness of the image is wholly dependent on the chemistry make-up of the ink when dealing with a total release ribbon. Every effort is made to provide an image which has as great a contrast as is consistent with other ribbon variables. Fortunately, the requirements for camera-ready copy, when using a process camera and film, are somewhat different than those of the human eye. The film used, within certain restrictions, does not register the fine tonal differences. This allows some latitude for character to character variables in color.

In manufacturing a ribbon to have the characteristics that have been listed, the manner in which the printed material will be handled and the material on which the ink will be deposited must be kept in mind. The "Selectric" Composer is designed for the two applications of camera-ready copy and direct image offset plates. These two applications present two entirely different surfaces to the machine and, consequently, to the ribbons used on the machine.

To meet these two distinct applications a special ribbon ink was formulated. This ribbon ink employs a different carrier from that previously used to hold the carbon, dyes and toner mixture which actually colors the ink. It was through development of this unique formulation that a ribbon displaying the necessary color, coverage and release qualities, to be called a reprographic ribbon, was made possible. It is sometimes referred to as a "solvent-based" ribbon because of the process involved in coating the base film with the carrier-carbon mixture, but this term is not really descriptive of its desirable qualities.

In addition to possessing the previously listed desirable characteristics, the 2122 ribbon is not soluble in fixative sprays, used to prevent smudging of copy when subject to handling, and it does not bleed through opaquing solutions used in making corrections. This means that camera-ready copy may be spray protected, pasted up for photographing, and any excessive glue readily removed from the copy without smearing. This is a common practice and one that has to be considered in making a reprographic ribbon.

The 2122 reprographic ribbon is a full release ribbon designed for use on direct image offset plates as well as paper. It will successfully image a broad range of clay coated or plastic coated plates that are presently marketed by the leading manufacturers. While erasing of any full release ribbon is difficult to accomplish, it has been found that if only the carbon mixture is removed, without removing the halo that surrounds the erasure, none of the remaining residue will print when run on the offset press.

PAPER

A varied number of papers are available under the general headings of Bond, Ledger, Offset, and Letterpress. Their characteristics are as varied as their application and yet, chemically speaking, they are very similar. To more completely appreciate these differences some understanding of the papermaking process is needed.

There are two major phases in manufacturing the finished paper stock. These phases, the chemical composition of the pulp, and the manner in which this pulp is calendered, largely determines the characteristics of the final product. The actual pulp fiber may come from either wood or rags and is an identifying characteristic.

Wood pulps are produced by both mechanical and chemical means. The mechanical method uses a grindstone and water to separate the fibers from the non fiber matter. The fiber length is controlled by the angle at which the wood stock is fed into the grinder, after which the chips are then floated free from the dirt and undesirable materials.

The chemical pulps are named for the chemical processes for obtaining the fibers from the wood. These

are: Soda pulp, Sulphate pulp, and Sulphite pulp. Sulphite pulp, a long strong fiber, is used for book, bond and similar papers. While each is chemically different, they are all aimed at reducing the wood stock to the fiber or pulp state.

Rag pulps are made from many different rag fibers and imparts its own special characteristic to the body of a paper. Cotton rags are the most satisfactory, although linen and other rags produced from vegetable fiber are equally useful. Animal and synthetic fibers have proven to be unsatisfactory for pulp.

After the grinding and cooking processes the pulp is washed to remove as much of the cooking chemicals and non-cellulose material as possible. The pulp is now labeled brown stock and is ready for bleaching.

The bleaching is accomplished by the addition of chlorine gas, hydrogen peroxide and other agents designed to whiten the pulp and yet not weaken the fibers.

After shredding, cooking and bleaching, the pulps are passed to the beater stage. Here the fibers are shortened, split apart and mixed with water to impart certain desirable physical characteristics. The length of

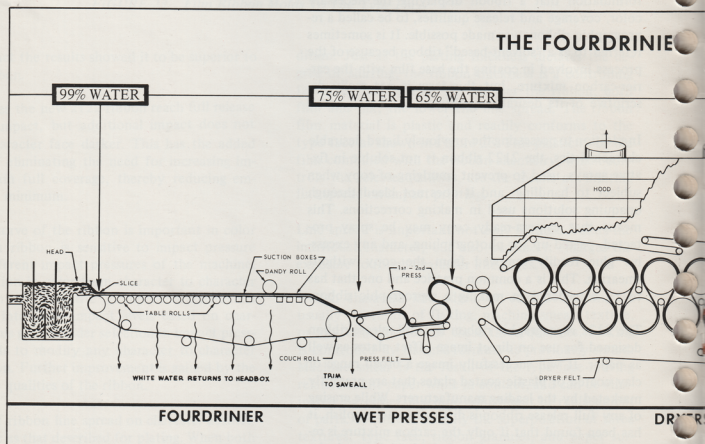


FIGURE 24. Four

the beating cycle and degree of fiber cutting allowed can be varied to produce pulps for papers with specific strength properties.

It is at the beater stage that other non-cellulose items are added to the pulp. These additives, binders, fillers, sizing and dyes are introduced to change inter-fiber bonding, improve physical and optical properties, improve liquid resistance and to color the finished paper stock if desired.

The binder is added primarily to increase the strength of the paper. The most important of these binders is starch. It forms a fiber-to-starch-to-fiber bond that is stronger than a fiber-to-fiber bond. There is also a decrease of surface fuzz and an increase of hardness and durability.

Fillers, such as clay, calcium sulfate, Titanium dioxide and talc are added to impart optical and physical qualities to the paper. The optical qualities are opacity and brightness, while the physical quality is smoothness of surface finish.

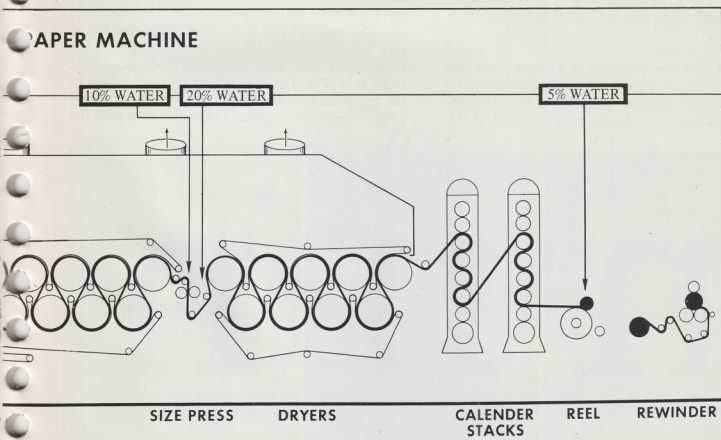
The third general additive to the stock pulp is sizing. The most commonly used sizing agent is rosin, a gum-

my substance that oozes from the cut surface of a pine tree. The purpose of sizing is to render the paper resistant, to some degree, to liquid. Writing papers, for example, are sized to preclude feathering and penetration of ink.

Nearly all colored paper is produced by adding suitable dyestuff in the beater operation.

The final pulp mixture is diluted with water and flowed onto an endless wire screen of a paper machine as shown in Figure 24. Here the web of paper is formed and the water removal process begins. The mixture is passed through presses and dryers composed of a series of cylinders and endless felts designed to press out more water through the screen, and to smooth and dry the sheet.

It is at this stage that the paper acquires two distinct sides, a felt side and a wire side, as a result of the pressing and drying against the screen. Just before the web of paper reaches the last set of dryers a sizing solution is sprayed on the paper to seal the surface pores. The sizing prevents the feathering or spreading of ink on the surface of the sheet and an increase in abrasion resistance is acquired.



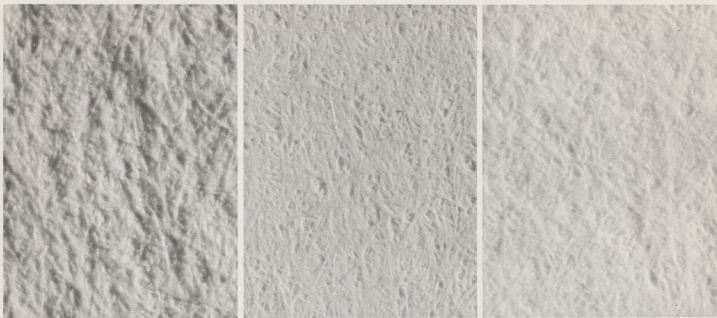


FIGURE 25. Paper Surface Variations

The final stage on the papermaking machine is a calender operation. Here the finish and bulk of the paper is determined. The web is passed through various combinations of rollers, under specific pressures, to control the thickness, smooth out the felt and wire marks and to obtain the desired surface finish. It is significant to note that some papers are not subjected to this final calendering step but are taken straight from the screen.

Papers that have been produced on a simple paper machine as previously discussed may vary considerably with respect to surface finish. While the strength, opacity, whiteness and toughness are a result of the

pulp mixture, the surface finish is the result of the final calendering operation. The paper surface can vary from smooth through rough as shown in Figure 25.

This surface finish becomes important if it is to be used for printing purposes. When the type face must use impact and a ribbon as an inking medium to image the paper then the surface finish becomes more critical. The result of this is shown in Figure 26. As the type face is made bolder, the successful imaging becomes more and more dependent upon the paper finish (Fig. 27). The presence of hills and valleys in the paper surface means that, in order to get complete coverage, the impacting character must push the



FIGURE 26. Image Variations Due to Paper Surface



FIGURE 27. Image Variations Become Emphasized With Bold Type

ink into these valleys. If the paper is easily compressible an increase in impact may allow successful imaging. A stiff, unyielding paper, however, may resist all efforts to imaging regardless of impact.

Since the impact force of the “Selectric” Composer coupled with the bold type styles is usually not sufficient to push ink into these valleys, the resulting voids within a character are produced.

The second phase of paper manufacturing, paper finish, is the most important phase when the paper is to be used with the “Selectric” Composer. The paper must possess certain desirable surface characteristics such as brightness, smoothness, and receptivity to carbon ribbon ink if the copy is to be satisfactory for photographing.

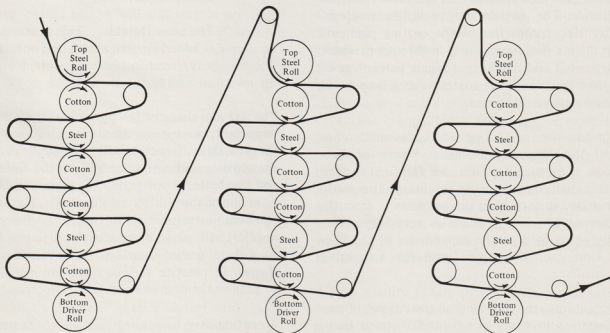


FIGURE 28. Supercalender Arrangement

Brightness, or whiteness, can only be obtained through the bleaching of the fibers during the initial paper-making process or through the use of brightening agents. On uncoated papers the brightness may be increased by surface sizing and lightly "coating" just prior to the final calendering operation.

When a smoother finished paper than that obtained from the papermaking machine is desired there are two possibilities. The paper may be supercalendered or it may be coated.

Supercalenders are composed of alternate rolls of steel and cotton, or steel and paper. They may be set to any desired pressure and have different surface speeds. There can be as many as eight rolls in a stack and as many as three stacks, arranged as shown in Figure 28, depending on the surface finish desired. When the resilient rolls come in contact with the steel rolls their diameter increases; as they disengage the diameter expands to its original size which produces a creeping effect. This creep in the resilient roll produces a polishing action on the paper surface next to the steel roll and this action imparts a gloss and smoothing quality to the paper. While this additional calendering produces a smoother surface for improved printing quality the answer may be found in coated paper.

There are numerous reasons for coating paper - gloss, slickness, high density, better color, brilliance, etc. However, perhaps two stand out above all others. The first of these is simply that a layer of pigment is a better base for printing ink than is a fiber surface. The inked image on a coated surface that is no smoother nor glossier than an uncoated one will show more life and brilliance. The particle size, packing characteristics and surface properties of the coating pigments will keep the ink film more nearly in the area in which it was deposited and will keep a higher percentage of it at or near the top of the coated layer where it will have the greatest visual impact.

The second reason for coating, and occasionally confused with the above, is smoothness. Where the coating process is of such a nature that the final surface is smoother than any that could be obtained normally on an uncoated surface, then this property of smoothness imparted by coating becomes very important. Especially so in light of the dependence of the "Selectric" Composer on paper finish for acceptable graphic quality.

Coating mixtures are composed of three types of materials dispersed in water to a paint-like consistency. There are pigments, adhesives and additives.

The adhesive is a glue, as the term implies, and is used to bond the coating to the paper. Additives are materials which are included to improve flow characteristics, help the coating operation, or to modify finished sheet characteristics. They may also be waterproofing agents, defoamers, tinting dyes, preservatives or dispersing agents.

The pigments are the wholly desirable part of coatings. They impart the brightness, covering power, gloss or dullness, and the printing qualities for which a coated paper is needed. Pigments are finely divided powders, and are mineral, or akin to mineral, in origin. The principal ones are:

- a. Clay — This is a sticky, plastic mineral occurring in nature which has been used by man for ages. When it is to be used for coating paper, only the white or near white grades are mined, purified to remove grit and foreign material, graded for particle size and bleached to improve the color. The finer the particle size of the clay used, the smoother and glossier will the paper surface become. Clay as a pigment is the backbone of the coating industry and paper may be, and often is, coated with it as the sole pigment.
- b. Calcium Carbonate — This is known as precipitated chalk and is chemically the same as limestone. The fine particle size adds openness and porosity. At any given particle size, it will be lower in gloss and more ink absorbent than clay.
- c. Titanium Dioxide — This synthetic pigment is added for brightness and opacity. It is always used in small amounts, 5% or less, as an additive.

The size and shape of the pigment particle used has an important bearing on the printing properties of the finished sheet. Generally the smaller the particle size, the glossier and smoother will be the finished sheet and the better it will print. The pigment particles will be in one of three different shapes, flat plates, needles, or rhombic (prismatic). In theory the flat plates and needles will pack more closely together and form smoother, denser coatings than will the rhombic shapes. In practice various types are mixed together to achieve the desired balance of properties.

A coating may be applied by running the paper over a series of rollers which both apply and meter the a-

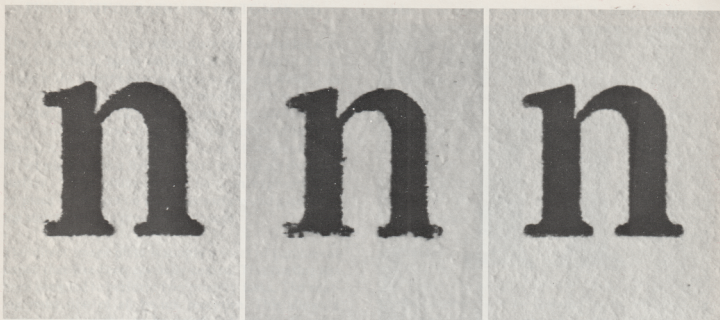


FIGURE 29. *Coated Paper Surface Variations And Bold Type*

mount of coating. This coating might then be modified by a blast of air from an air knife, scraped by a trailing steel blade or smoothed by a series of brushes. The coating process may also include two stages of any one process or a combination of these processes. A further mechanical treatment of the dried coated sheet to produce smoothness and gloss is generally necessary. This is usually a calendering operation employing alternate rolls of steel and cotton or steel and paper dependent upon the coating and finish desired. The final product is a paper that is both smooth and receptive to ink.

The finished coated papers will still vary in printing characteristics but their qualities are generally superior to that of supercalendered papers. An example of the graphic quality obtainable from the "Selectric" Composer using machine coated papers is shown in Figure 29.

The aristocrat of coated papers is cast coat. It consists essentially of pressing the wet coated surface of a sheet against a heated, highly polished chrome plated cylinder. This allows the coating to dry on the paper while in intimate contact with the heated drum. This process leaves the paper with a very glossy and smooth surface. Production of cast coated paper is both slow and expensive. However, it is outstanding in appearance.

The surface of this paper is so slick and smooth that it lacks the minute surface roughness, or tooth, necessary for the carbon ribbon ink to transfer from ribbon to paper. Attempts to image this paper may produce the results shown in Figure 29A.

Paper finish, as shown by the preceding examples, is the most important phase of paper manufacturing when related to direct impression machines. The receptivity to ink and degree of smoothness are important paper qualities to be considered.

In summary then, a paper's characteristics are determined by its composition and the finishing process. For a paper to be used with the "Selectric" Composer it must have a smooth and receptive surface. Papers with these qualities will generally fall in the classification of either ledger or coated papers. The degree of success in imaging these papers with the "Selectric" Composer will be largely determined by four factors. They are the typestyle, print velocity, compatibility between the ribbon and paper, and, finally, surface smoothness of the paper. Of the four factors, paper is the one variable. Yet it can prove most difficult to diagnose as a cause of poor print quality. This is because the compatibility factor (paper receptivity to ink) can produce similar character voids and line breaks to that produced by a rough paper. Any undesirable printing characteristics, whether due to an incompatibility factor or paper smoothness, will usually vary with character size. That is, voids will be more pronounced in the bolder and larger typestyles, while a lack of sharpness will be more noticeable in the smaller typestyles.

A print quality failure that is attributed to either paper roughness or supply incompatibility should be resolved so that the recommended ribbon is used for the proper application. If the copy is to be photographed, the paper should allow the use of a ribbon that will produce characters that have good edge def-

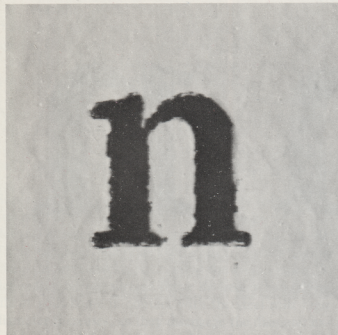


FIGURE 29A. Cast Coated Paper

inition, without voids and uniform in color and line weight. Generally speaking, coated paper will give better results in attaining these standards than ledger papers. While this may mean using a coated paper for composition, the superior printing qualities of coated paper are universally recognized by printers and a recommendation on this basis will be understood and accepted.

PHOTO LITHOGRAPHY OR PLATE MAKING

The preparation of an offset plate can be divided into two categories, based on methods of imaging. First, there is the direct image plate or master on which you can draw, type or letter using a medium that will place a water repellent film on the plate. The second category, and the most frequently used method in print shops, is centered around the use of photography and offset plates with a light sensitive coating on the plate surface. These plates require both an exposure step to place the image on the plate surface and a developing step to fix and produce the image.

The direct image plate is simply a sheet of parchment paper that has been specially coated. This coating has been designed to perform two primary tasks. The coating must first of all be ink receptive. This allows a complete character to be lightly placed on the surface. The coating must also act as a water barrier between the paper base and the fountain solution during the press operation, yet provide a surface to which water will cling. Direct image plates usually are classified as either clay coated or plastic coated and refers to the coatings used.

Clay coated plates are more popular than the plastic coated plates. The clay coated are easier to make corrections on and they handle easier on the offset press. However, they are not as durable as the plastic coated

plates. The plastic coating, with its tough surface finish, produces a plate with a longer press life than a similar level clay coated plate.

Corrections are made on these plates by using an eraser that accepts grease readily, yet contains no harsh abrasives that will damage the coating. To prevent an image from printing only the greasy film must be removed. Care must be taken not to penetrate the coating or create a low spot when erasing. If the coating is removed, water will penetrate to the paper when the plate is on the press and ruin the plate. When using carbon ribbon and an erasure has been made on a plastic plate, a correction fluid must be applied; otherwise, the correction will wash off.

The correct impression setting to use on the "Selectric" Composer will be dictated by the ribbon being used, type of plate, type style, and the individual machine adjustments. A rule of thumb is to use the lowest possible setting that will give total character coverage. Too high an impression setting will cause excessive embossing of the plate by the type face and result in hollow characters when the plate is run on a press. In addition, the erasability is impaired with excessive penetration by the type face. If a plate is allowed to stand for a short period of time before being run, the compressed fibers will regain some of their original shape. This expansion of the fibers brings the image closer to the plate surface, and helps to eliminate the hollow characters caused by embossing.

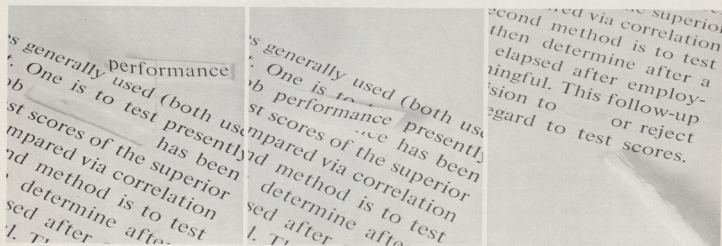


FIGURE 30. Methods of Correcting Line Copy

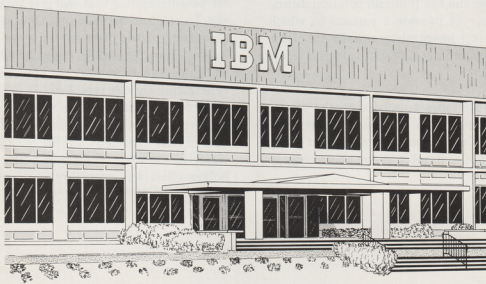
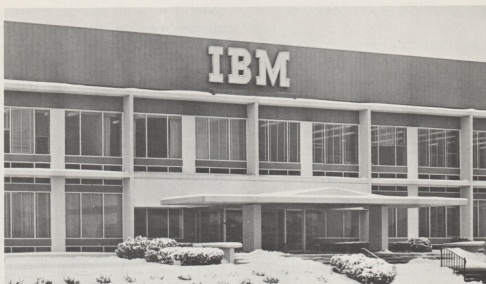


FIGURE 31. *Halftone and Line Material*

The second method of making offset plates, by exposing a light sensitive plate to a negative, requires a series of steps. These include the preparation of the text or line copy, photographing to obtain a negative, making a layout, exposing the negative and plate to a light, and developing the plate.

Line copy is composed on smooth, dull finished, white or clay coated paper. Corrections are made in one of three ways, stripping in of corrections, paste-overs, and by using an opaquing fluid to delete the error and typing over the opaqued area (Fig. 30). By far the most popular method of making corrections, and the most satisfactory when quality is important, is by stripping. This is done by typing the correct word on a separate sheet of paper, placing the correction over

the incorrect word, and cutting through the correction sheet and bottom sheet with one cut. The block with the incorrect word is removed, the correction block is inserted in the cut-out space and then secured by a piece of tape on the back side. A paste-over or opaquing often leaves shadow lines on a negative that must be painted out, or at least require special camera and lighting techniques for elimination, and are not as satisfactory as stripping.

Photographing copy for offset plates is only a small segment of the field of photography. The term "photolithography" is sometimes used for that portion of the graphic arts where photographic methods are used to reproduce printed material or illustrations on plates. The two categories of negative making are

commonly called "line" and "halftone" (Fig. 31). Such work as pen and ink drawings, sketches, type-written copy, ruled graphs and solids are in the classification of line copy. Photographs or anything with tonal qualities are in the classification of halftone, and are handled quite differently from line copy.

The photographic equipment most commonly used is a process camera. It consists of a movable copy board to hold the material to be photographed, a movable lens, and a focal plane where the image is focused and the film is placed (Fig. 32). The focal plane, or back, of most cameras is equipped with a vacuum unit that hold the sheet perfectly flat during an exposure and is usually stationary. A ground glass plate can be inserted at the focal plane for focusing purposes. High intensity lamps, usually carbon arc, straddle the rails on which the lens and copy board travel. The copy board and lens are moved both for proper image size and proper focus of the image. The sheet of ground glass can be inserted to verify the correctness of image size and focus.

Once the camera has been set up, a sheet of process film (orthochromatic) is inserted at the camera back. Unlike more conventional films, orthochromatic is not sensitive to the entire color spectrum and may be safely handled under a red light without exposing the film. This film has the characteristics necessary to produce printing images on a plate that have sharply-defined printing areas. This film is slow and extremely contrasty, recognizing only light and dark. The grain of the film is very fine and will reproduce thin lines of the copy with sharpness.

The exposure time for the film can vary from five seconds up to three minutes or longer. The factors that influence the exposure time, in addition to the speed of the film, are the lens opening, intensity of the lights, image to original ratio and whether a line or halftone negative is being made. In determining the correct exposure time, the general principle of exposing and developing for the background rather than the image is followed. When reproducing line material, the desired result is a negative possessing a clear sharp

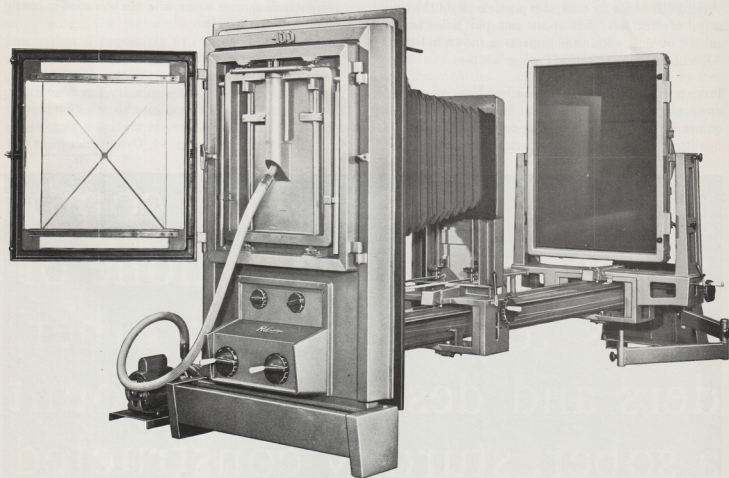


FIGURE 32. Process Camera

pe face, Press Roman combi
appearance. It has none of
rokes found often in other
ders and descenders account
a sober, sturdily constructed

FIGURE 33. *Negative With Pinholes and Shadows*

image against a dense or black background. In actual practice, however, the cameraman will vary the exposure time to obtain certain desirable results. By varying the exposure time, it is possible to rid the negative of shadows, dirt spots and pin holes (spots caused by dust within the camera) as shown in Figure 33. Note also the effect on the line width.

Process camera lenses are at their best only when used at openings within certain limits. Larger or smaller openings invariably decrease sharpness, a very desirable quality in line work. This characteristic encourages

the practice of keeping the lens opening constant and varying the time for proper exposure. However, the lens on a process camera is no different from more conventional camera lenses, and can be varied in opening for a desired result.

Once the exposure has been made for the background, final image sharpness of the negative depends upon developmental techniques. A quality reproduction is one in which the background goes black within recommended development time, producing a clear sharp image as shown in Figure 34. Overdevelopment will

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appearance. It has none of
rokes found often in other
ders and descenders account
a sober, sturdily constructed

FIGURE 34. *Negative Without Pinholes and Shadows*



FIGURE 35. *Character Line Variations Due to Developing Procedure*

cause a loss of detail in the image area, a reduction in line thickness and possibly produce breaks in a thin line. Underdevelopment can cause a less-than-sharp image with thick fuzzy lines also shown in Figure 35.

The other segment of photomechanics is that portion concerned with halftones. A halftone negative is the term applied to the results from the process of reproducing a photograph for press work. Since an offset plate is either ink receptive or water repellent, it will either accept ink uniformly or repel it completely. This makes it impossible to exactly duplicate tonal variations with a printing press. Therefore, a technique is employed to capture tonal variations optically and yet register them on process film in such a manner that the human eye will interpret them as tones. This is done by breaking shaded areas into a field of dots.

The larger the dots, the darker the shading will appear to the eye. The intermediate halftone process then, a process that breaks up tones into solid dot entities, is the key to graphic reproduction of photographs and art work.

The tones of a photograph are broken up into a dot pattern by placing a screen between the subject and the film. This screen may be a contact screen placed directly on the film, it may be a glass screen located between the film and the lens, or it may have been processed in the film itself. Generally a glass screen consists of two series of parallel lines, one series perpendicular to the other series, and is identified by the number of lines per inch. Thus, a 133 line screen produces 133 lines per inch on the halftone negative. There are screens available with other patterns, such as circular, to produce eye catching effects.



FIGURE 36. *Halftone Screened With Coarse and Fine Screen*

A contact screen, the one most commonly used today, is merely a piece of film on which the ruled lines have been placed. Contact screens are not as fragile as glass halftone screens. They also provide better rendition of tone, because the dots take the form of the subject detail and create a smoother optical illusion. They are easily scratched, however, and they may also be marred by waterspots, fingerprints, and the edges of the film.

By placing a screen so that it intercepts the light rays emanating from an image, the intersecting lines break the tonal values into a dot pattern. The lighter the tone, the smaller the dots appear. As the tones darken, the dots become larger, and finally merge to produce the dot pattern that the human eye interprets as a continuous dark tone. This dot pattern then registers on the negative producing just the reverse of the above.

The number of lines on the screen (or size) is dictated by the amount of detail desired, type of press and the paper employed in the press run. Very fine screens, those with a large number of lines per inch, produce halftones of higher quality than coarse screens. Fine screens produce dots that are closer together, thus making it harder to see individual dots (Fig. 36).

Once the negatives have been made, they must be "stripped" together into their proper relationship. A yellow or orange ruled layout sheet (printer's flat) is used to correctly position the negatives. This color is employed because it holds back the ultraviolet light used in exposing the finished plate, and is commonly called the "goldenrod" sheet. The negatives are taped to the goldenrod sheet and those areas of the goldenrod that overlay the printing areas are cut out (Fig. 37). This is easily accomplished by using a sharp razor blade or knife. The final step is to touch up any minor pin holes or faults in the negative by using opaquing fluid and a small brush.

The finished goldenrod sheet, holding the corrected negatives, is now ready to be contact printed on a light sensitive plate. The plate may be either grained zinc or aluminum with a coating of albumin, or it may be what is known as a presensitized plate coated with a diazo compound. The major difference is that those coated with albumin are usually coated by the print shop and can be reclaimed by removing the old image through a process of resurfacing. The presensitized plate is a commercial item and is not reclaimable by the printer.

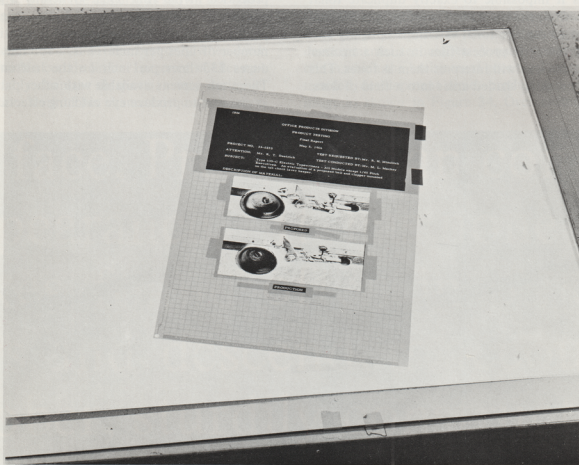


FIGURE 37. Goldenrod With Line and Halftone Negatives

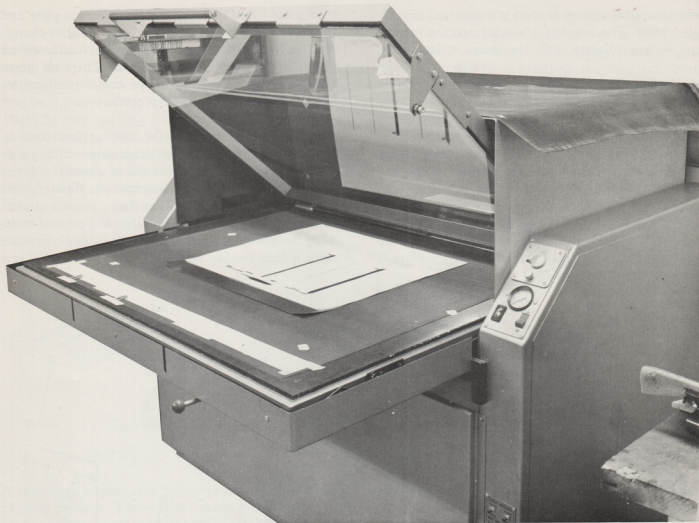


FIGURE 38. *Platemaker With a Plate and Goldenrod in the Vacuum Frame*

The goldenrod is placed in direct contact with the plate and exposed to an arc lamp. During exposure on a negative acting plate, the coating is hardened where it is struck by light, but the unexposed coating or nonprinting area is not changed. After exposure the albumin plate is covered with a thin layer of ink. The plate is then soaked in water and the soft unexposed coating is washed away, leaving the desired image on the plate. The plate is then etched to make the nonprinting surfaces less sensitive to ink, and to provide a surface that will retain water when the plate is placed on the press. It is also gummed to prevent oxidizing or corroding from exposure to the air.

Development of a presensitized plate requires the use of a chemical solution to dissolve the coating in the nonprinting areas. Afterwards, if it is a metal plate, the image areas are covered with lacquer and the plate is gummed. Although presensitized plates are a relatively recent development, they have caught on rapidly and are used extensively throughout the industry. These plates come to the platemaker ready to use, and are available in either plastic or metal.

Two other common methods of plate making are worth noting. These are diffusion transfer method and electrostatic method.

The diffusion transfer process differs from other plate-making processes in that the plate is not covered with a light sensitive coating. Instead, a special photographic negative material is exposed by contact or reflex printing from a final line copy, or through use of a camera or enlarger. After exposure, the negative and the plate, which may be either aluminum or plastic, are fed into a developing solution and are then pressed together by rollers (Fig. 39). The developer changes the exposed

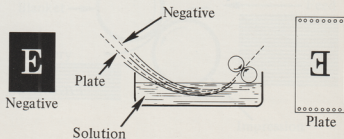


FIGURE 39. *Diffusion Process*

silver salts and the image formed is transferred directly to the plate. The negative is peeled off, the plate is fixed with a solution, and the image is lacquered.

The electrostatic process may employ either direct image or metal plates in conjunction with a copy machine (Fig. 40). Essentially, the electrostatic copying process is used except that a selenium-coated plate is substituted for the copy paper. First, the plate is electrically charged, then light is reflected from the line copy through a lens to the plate. The light dissipates the electrical charge on the plate except where the image has failed to reflect the light. The plate is then dusted with a black resinous powder that is attracted only to the charged image areas. An offset plate is

then placed face to face with the selenium plate and the powder is transferred with another positive charge. Heat is then used to fuse the powder to the offset plate and make the image permanent. There are minor variations on the electrostatic process, but all revolve around this relatively simple procedure.

There are other processes for making plates that involve transferring an image from prepared copy directly to a plate through the use of a special negative paper similar to the diffusion process. Most of these processes produce plates faster than a process camera. However, the process camera offers the greatest versatility in producing either halftone or line negatives with a high quality image.

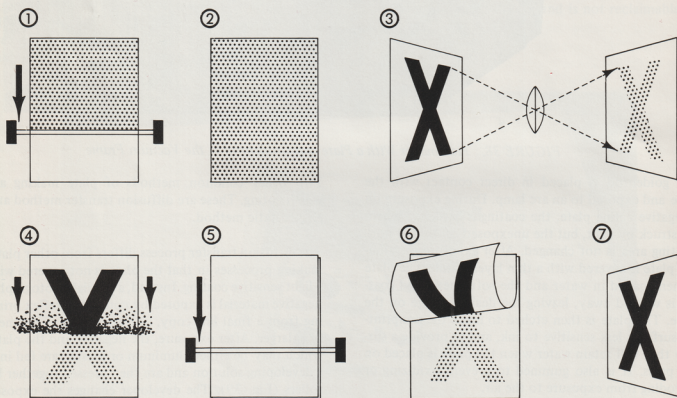


FIGURE 40. *Electrostatic Process*

OFFSET LITHOGRAPHY

Invented in 1798 by Alois Senefelder, lithography literally means "writing on stone". He found that when designs were drawn on porous limestone with a greasy crayon a greasy image was absorbed by the stone that could be removed only by resurfacing. By keeping the stone dampened with water, he could re-ink the design and, by applying pressure, transfer it to sheets of paper as shown in Figure 41. This basic principle of lithography - the mutual repellency of grease and water - is still in use on modern presses. This method of reproduction was slow and laborious, however, so the next step was to eliminate the unwieldy litho stone as a printing surface.

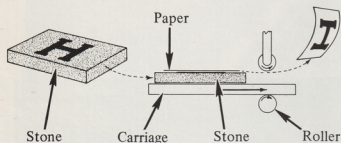


FIGURE 41. *Litho Stone*

A clean and grained zinc plate was substituted for the printing surface. The original image was transferred from the stone onto a specially coated paper. The coated paper was then pressed against the grained plate with sufficient pressure to transfer the inked image from the paper to the plate. At this point the plate resembled the stone surface in that a grease image had been placed on the surface of the metal (Fig. 42). After desensitizing the nonprinting surface, to insure there were no grease spots and that those areas would retain water, the plate was ready for the press.



FIGURE 42. *Image on Metal Plate*

The second step forward in lithography was the design of a two cylinder press to use the newly developed plates. Instead of an unwieldy stone reciprocating back and forth on a flatbed, the plate was clamped to a cylinder with a second cylinder as a pressure roller as shown in Figure 43. Here was a press that could run as fast as a man could feed it. When semi-automatic dampening and inking mechanisms, automatic feeders and chain deliveries were added the speed jumped to 3500 impressions per hour.

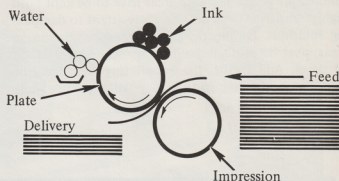


FIGURE 43. *Two Cylinder Press*

One of the biggest drawbacks to this press was the short life of the plates. The image on the plate would wear, or "walk off" the plate making it useless. This sensitivity of the plate image to pressure and to surface roughness of the paper stock led to further refinement of the lithographic press.

The wear problem was solved by printing the image on a rubber blanket and then "offsetting" it from the blanket to the paper. The plate and pressure cylinders were retained and a blanket cylinder was inserted between the two as shown in Figure 44. The plate is first wet with water, then ink, and then transfers both water and ink to the blanket. The blanket in turn

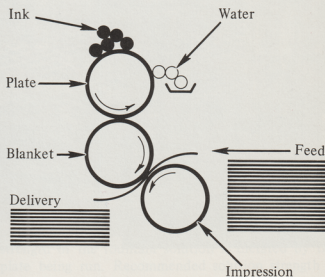


FIGURE 44. *Three Cylinder Offset Press*

transfers both films in their proper areas to the paper. This is, in essence, the same offset press being used today. The recent major changes have been in the process of placing the image on the plates rather than in the offset press. Today not only metal but clay and plastic coated paper plates are used. And the image may have been placed on the plate by a typewriter, a negative, or through use of a copy machine.

A pressman must keep several things in mind when running a plate. The image areas have to be kept both highly sensitive to ink and highly resistant to dampening solutions. During the press operation, the image areas must be protected with a healthy film of ink at all times. And finally, the nonprinting areas must be kept water receptive so that they will repel ink while

in a moistened state. Since the plate surface is flat with both the ink and dampening rollers of the press contacting the entire plate, the surface must be kept chemically selective, each area accepting what is meant for it and repelling the other.

A plate will fail to perform in two major ways, the first being that the non-image areas break down and accept ink. This defect is called "scumming" or "catchup" and depends on how the defect occurs. The second way that a plate may fail is that the printing image refuses to properly accept and retain ink. In such cases the image fails to take ink and becomes "blind", or the image base breaks up and walks off the surface of the plate.

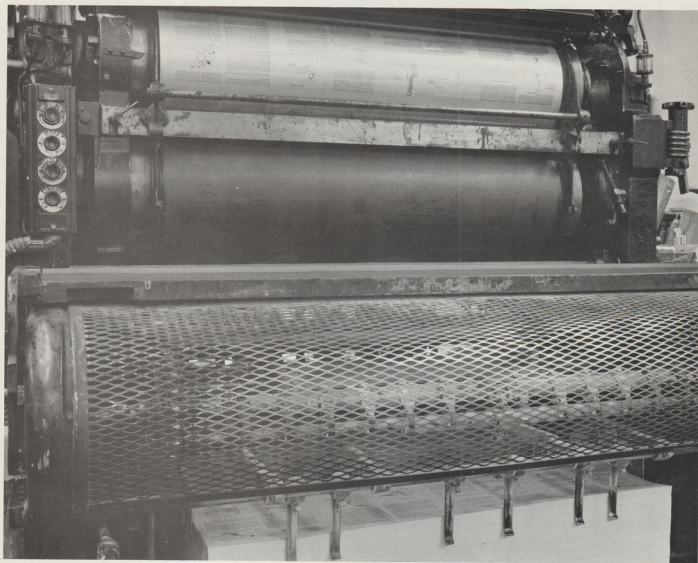


FIGURE 45. Offset Press

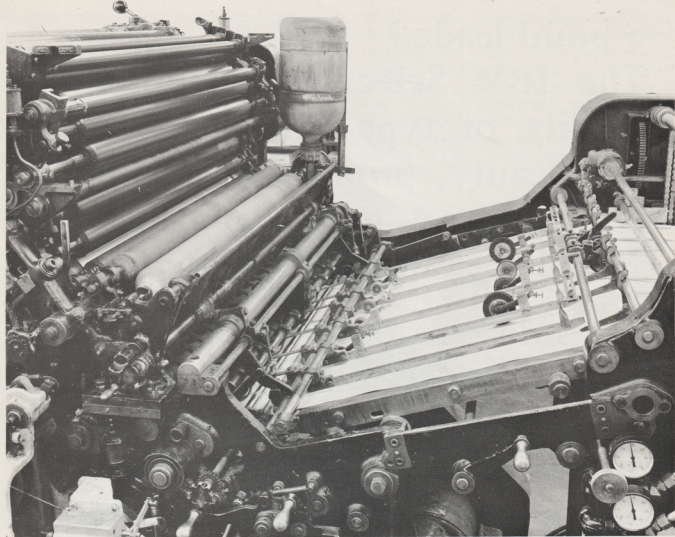


FIGURE 45A. Offset Press, Rollers, and Paper Feed Unit

An offset press may be said to have five units. The printing unit or cylinder arrangement, the inking system that supplies the ink to the plate, the dampening system, the paper feed unit, and the delivery mechanism. Figure 45 shows an offset press that could be found in a typical printing shop.

The most important single item in the printing unit is the pressure between the cylinders. This pressure is adjusted between the cylinders so that the ink and water films transfer completely but with a minimum pressure. Excess pressure will produce worn plates, "picking" of coated papers, and paper curling. When the plate wears from excessive pressure more water is required which in turn causes more difficulties. The primary operator complaint will be that a plate doesn't run as long as it should.

The dampening system is perhaps the weakest and most troublesome unit of the offset press. Proper dampening of a plate entails a great deal of skill. The amount of moisture required to keep a plate clean de-

pends on several factors; the amount of ink being run, the area occupied by the image, and the ability of the plate to hold water.

When running a paper plate, the condition of the water barrier on the plate surface must not have been damaged by abrasion. The dampening system consists of a series of cloth covered rollers that transfer the water (fountain etch) to the plate from the fountain roller. The water flow is controlled only by regulating either the speed of the fountain roller or the length of time the secondary rollers can draw water from the fountain roller. The fountain solution itself requires careful control. If the chemicals in the water are too strong, the image will disintegrate or walk off the plate during the run. On the other hand, if they are too weak, the nonprinting areas of the plate may become receptive to ink and "scum" will develop. The strength of the fountain solution is dictated by the plate being run. Recommended solution strength is included with the instructions on each package of plates and should be followed.

3 point leaded

The IBM Selectric Composer set quality of type—approaching more the beauty, proportion and readability composes. A text composition in complete range of classic type f

FIGURE 46. Offset Run With Thin Ink Film

3 point leaded

The IBM Selectric Composer set quality of type—approaching more the beauty, proportion and readability composes. A text composition in complete range of classic type f

FIGURE 47. Offset Run With Heavy Ink Film

The inking system measures and distributes the ink. Keys in the fountain are adjusted to control the amount of ink and its distribution. The ink system also uses, in addition to the keys, a series of rollers designed to work the ink into a fluid condition and to spread an even film of ink over the surface of the plate.

The paper feed unit merely delivers the paper into the printing unit at the same place each time for registration purposes. After printing, the delivery unit carries the paper to a stacking platform. These units are mechanical in nature and any failure is readily apparent to an operator.

Once the printing unit has been set to the proper pressure, the factors that may influence the run of the plate are the fountain solution (water) and the balance between the water and ink. The importance of

the proper acid level of the fountain solution has already been mentioned and the defects that may arise from weak or strong solutions has also been noted. The greatest problem area is that of water and ink balance. This is probably due in no small part to the weaknesses in the dampening system.

The variations in ink film thickness that can be run on a plate are confined to rather narrow limits. If the film is too thin, there is danger of exposing the image base to the dampening solution and the plate may go blind (Fig. 46). Too much ink, however, is the more common offense. It is indicated by filled up half tones, thick letters and a tendency of the plate to catch up on the press (Fig. 47). The usual reaction is to increase the water feed.

Use of too much water will not compensate for the use of too much ink. Washed areas on the plate will

develop, the printing will be gray and dull, and ink drying will be retarded (Fig. 48). In addition, excess water may find its way to the ink rollers and ink fountain. This can cause emulsification and caking of the ink. Once this happens, the ink will fail to protect the image on the plate and a damaged plate is the inevitable result.

A successful press operation is primarily contingent on a total image having been placed on a plate and

the non-image areas being water receptive. This lays the initial burden on the plate preparation. Therefore, the composition machine that originally prepared the master image holds the key to a successful duplicating job. It must be capable of producing a clean sharp image on a paper before any thought can be given to plate preparations. Once this has been proven and the text has been prepared, then the necessary intermediate steps can be confidently taken to bring a finished plate to the press.

3 point leaded

The IBM Selectric Composer set quality of type—approaching more the beauty, proportion and readability composes. A text composition in complete range of classic type from seven to twelve points. And

FIGURE 48. Offset Run With Excess Water, Heavy Ink Film

3 point leaded

The IBM Selectric Composer set quality of type—approaching more the beauty, proportion and readability composes. A text composition in complete range of classic type from seven to twelve points. And

FIGURE 49. Offset Run With Proper Balance of Ink and Water

GLOSSARY OF TERMS

- Agate Line** - A standard of measurement for depth of columns of advertizing space. Fourteen agate lines make one column inch.
- Antique Finish** - A term describing the surface, usually on book and cover papers, that has a natural rough finish.
- Ascender** - That part of the letter which rises above the main body, as in "b".
- Base** - On composition, all the metal below the shoulder of a piece of type.
- Banday** - A method of laying a screen (dots, lines and other textures) on art work or plates to obtain various tones and shadings.
- Blanket** - In offset-lithography, a rubber-surfaced sheet clamped around the cylinder, which transfers the image from plate to paper.
- Bleed** - If the printed image extends to the trim edge of the sheet or page, it is called bleed.
- Blowup** - An enlargement.
- Bond Paper** - A grade of writing or printing paper used where strength, durability, and permanence are essential requirements.
- Book Paper** - A general term used to define a class or group of papers having common physical characteristics that, in general, are most suitable for the graphic arts. The basic size is 25" x 38".
- Calendar** - A set or stack of horizontal cast-iron rolls at the end of a paper machine.
- Cast Coated** - Coated paper dried under pressure against a polished cylinder to produce a highly glossed enamel finish.
- Chase** - A rectangular metal frame in which type and plates are locked up for printing.
- Coated Paper** - Paper having a surface coating which produces a smooth finish.
- Contact Print** - A photographic print made from either a negative or a positive in contact with sensitized paper, film, or printing plate.
- Continuous Tone** - A photographic image which has not been screened and contains gradient tones from black to white.
- Dandy Roll** - In papermaking, a wire cylinder on papermaking machines that makes wove or laid effects on the texture, as well as the watermark itself.
- Descender** - That part of the letter which extends below the main body, as in "p".
- Display Type** - In composition, type size larger than the text, used to attract attention.
- Dot** - The individual element of a halftone.
- Double Dot Halftone** - Two halftone negatives combined into one printing plate, having greater tonal range than a conventional halftone. One negative reproduces the highlights and shadows; the other reproduces middletones. Used primarily in offset-lithography.
- Dropout** - A halftone with no screen dots in the highlights.
- Duotone** - A term for a two-color halftone reproduction from a one-color photograph.
- Em** - The square of a type body. So named because the letter "M" in early fonts was usually cast on a square body.
- En** - One-half the width of an em.
- Face** - The printing surface of a piece of type.
- Felt Side** - The top side of the sheet in paper manufacturing.
- Flat** - Or printers flat; the assembled composite of negatives or positives, ready for platemaking.
- Flush Left or Right** - Type set to line up at the left or right.
- Font** - A complete assortment of type of one size and face.
- Form** - Type and other matter locked in a chase ready for printing.

- Format** - The size, style, type page, margins, printing requirement, etc., of any magazine, catalog, book or printed piece.
- Furniture** - Wood or metal blocks used to fill blank spaces in a form.
- Galley** - A shallow metal tray used to hold type.
- Galley Proof** - A proof taken of type standing in a galley, before being made up into pages.
- Halftone** - A reproduction of continuous tone artwork, such as a photograph, with the image formed by dots of various sizes.
- Highlight** - The lightest or whitest parts in a printed picture, represented in a halftone by the smallest dots or the absence of all dots.
- Imposition** - The laying out of type pages in a press form so that they will be in the correct order after the printed sheet is folded.
- Ink Fountain** - The container which supplies ink to the inking rollers.
- Justify** - To space out lines uniformly to the correct length.
- Layout** - The drawing or sketch of a proposed printed piece.
- Leaders** - Rows of dashes or dots used to guide the eye across a page.
- Leads** - Thin strips of metal placed between lines of type to separate them vertically.
- Ledger Paper** - A grade of business paper generally used for record keeping.
- Makeready** - The building up of the pressform, in letterpress, so that heavy and light areas print with the correct impression.
- Makeup** - The arrangement of lines of type and illustrations into pages of proper length.
- Matrix** - A mold in which type is cast in linecasting machines.
- Opacity** - That property of a sheet of paper which minimizes the "show-through" of printing from the back side or the next sheet.
- Overlay** - A transparent or translucent covering over copy where color break, instructions or corrections are marked.
- Panchromatic** - Photographic film sensitive to all colors.
- Paper Master** - A paper printing plate used on an offset duplicator.
- Pica** - Printer's unit of measurement used principally in measuring lines. One pica equals 12 points or .166044 inches.
- Point** - Printer's unit of measurement, used principally for designating type sizes, and is .013837 inches.
- Primary Colors** - In light they are red, green and blue. In printing inks they are magenta (process red), yellow and cyan (process blue).
- Register** - Fitting of two or more printing images upon the same sheet of paper in exact alignment with each other.
- Screen** - Glass or film with cross-ruled opaque lines or vignetted dots used to reproduce continuous tone artwork such as photographs.
- Scum** - A greasy film which tends to sensitize non-image areas in a plate to accept ink.
- Set-Off** - When the ink of a printed sheet rubs off or marks the next sheet as it is being delivered.
- Signature** - The name given to a large printed sheet after it has been folded to the required size for binding.
- Sizing** - That property of paper which relates to its resistance to the penetration of liquids.
- Slug** - A one-piece line of type. Or a strip of metal, usually 6 points, used for spacing.

Stripping - The arranging of negatives in their proper position on a flat prior to platemaking.

Supercalendar - A calendar stack used to alter the surface properties and appearances of paper.

Tooth - The quality of a paper which causes it to take ink readily.

Type Gauge - A printer's tool calibrated in picas used to measure the various sizes of type.

Web - A roll of paper used in the web or rotary presses.

Wire Side - The side of a sheet next to the wire in manufacturing; opposite from felt side.

Xerography - Process used to make small lithographic plates, by transfer of image formed by a light-sensitive electrostatic charge on a special base.

